

5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

1,3-Dichloropropene is not a naturally occurring compound (IARC 1986). It is produced synthetically and may be released to the atmosphere in fugitive or accidental emissions during its manufacture, storage, and transport. It is also released to air during its use as a soil fumigant. Sewage treatment facilities (Lao et al. 1982; Rawlings and Samfield 1979), petroleum refineries (Snider and Manning 1982), and electricity-generating power facilities (Bean et al. 1985) can release 1,3-dichloropropene to surface waters. Chlorination of organic substances during the treatment of drinking water also can form 1,3-dichloropropene; therefore, the compound is a potential contaminant in drinking water (Dowty et al. 1975a, 1975b; Krijgsheld and Van der Gen 1986; Otson 1987; Rogers et al. 1987).

1,3-Dichloropropene may leach into groundwater and soil from landfills and hazardous waste sites (Hauser and Bromberg 1982; Sabel and Clark 1984). The most common release of 1,3-dichloropropene to soil occurs during the application of the chemical to agricultural fields when used as a soil fumigant (Cohen 1986; Krijgsheld and Van der Gen 1986; Maddy et al. 1982a, 1982b). Accidental spills may also release 1,3-dichloropropene to the environment (Markovitz and Crosby 1984; Sterrett et al. 1986).

Possible routes of human exposure to 1,3-dichloropropene include inhalation, ingestion of contaminated foods and drinking waters, and dermal contact. High levels of exposure to 1,3-dichloropropene are most likely to occur in occupational settings where 1,3-dichloropropene is either produced or used as a soil fumigant (Albrecht 1987b; Albrecht et al. 1986; Markovitz and Crosby 1984; Nater and Gooskens 1976; Osterloh et al. 1984, 1989a, 1989b; van Joost and Jong 1988; Wang 1984). The National Occupational Exposure Survey (NOES) conducted by NIOSH between 1981 and 1983 has determined that 1,779 workers are potentially exposed to 1,3-dichloropropene (NIOSH 1989). The NOES data base does not contain information on the frequency, concentration, or duration of workers' exposure to any of the chemicals listed therein. The survey provides only estimates on the number of workers potentially exposed to chemicals in the workplace. Intake by inhalation or dermal contact is the most probable route of workplace exposure to 1,3-dichloropropene. 1,3-Dichloropropene is a volatile compound and, after soil application as a fumigant, a fraction of the compound will volatilize and escape into the atmosphere (Krijgsheld and Van der Gen 1986). Inhalation and dermal contact are probably the major sources of exposure to workers.

The EPA has identified 1,177 NPL hazardous waste sites. cis-1,3-Dichloropropene has been identified at three of the sites evaluated for the presence of this chemical (View 1989); soil, water, and air samples have not been differentiated. However, we do not know how many of the 1,177 NPL sites have been evaluated for this chemical. As more sites are evaluated by the EPA, the number may change. The frequency of these sites within the United States can be seen in Figure 5-1.

5. POTENTIAL FOR HUMAN EXPOSURE

5.2 RELEASES TO THE ENVIRONMENT

5.2.1 Air

1,3-Dichloropropene is produced synthetically and may be released to the atmosphere as fugitive or accidental emissions during its manufacture (Leiber and Berk 1984; van Joost and Jong 1988), transport (Markovitz and Crosby 1984; Sterrett et al. 1986), and storage (Albrecht et al. 1986). For example, on April 8, 1984, a rail accident that occurred about 45 miles southeast of Tucson, Arizona resulted in a spill of 15,000 gallons of 1,3-dichloropropene. During the clean-up, which took place between August 1984 and March 1985, approximately 19,000 pounds of 1,3-dichloropropene were released to ambient air by an aeration process (Sterrett et al. 1986).

A major anthropogenic release of 1,3-dichloropropene to the atmosphere occurs during its application as a soil fumigant (Albrecht 1987; Markovitz and Crosby 1984; Osterloh et al. 1984, 1989a, 1989b).

5.2.2 Water

Very little information regarding the release of 1,3-dichloropropene to water was found in the available literature. A survey of sewage treatment facilities demonstrated that 1,3-dichloropropene may be released to surface waters via primary and secondary effluents (Lao et al. 1982; Rawlings and Samfield 1979). Waste water effluents from petroleum refineries also release 1,3-dichloropropene to surface waters (Snider and Manning 1982). In addition, trace quantities of 1,3-dichloropropene are formed during the chlorination of cooling water, which prevents biofouling at electricity-generating power facilities (Bean et al. 1985). Consequently, discharged cooling waters from electricity-generating stations and industrial facilities may release 1,3-dichloropropene to surface waters. Treated waste water from paint and ink formulation processes and waste water from 1,3-dichloropropene production sites can also release 1,3-dichloropropene to surface waters (EPA 1981).

Chlorination of organic substances in treated water supplies also can form 1,3-dichloropropene, releasing it to drinking water (Dowty et al. 1975a, 1975b; Krijgsheld and Van der Gen 1986; Otson 1987; Rogers et al. 1987).

Groundwater contamination can occur at and near agricultural fields where 1,3-dichloropropene has been used as a soil fumigant (Cohen 1986; Krijgsheld and Van der Gen 1986; Maddy et al. 1982b). 1,3-Dichloropropene may also be released to groundwater via landfills and hazardous waste sites (Hauser and Bromberg 1982; Sabel and Clark 1984).

1,3-Dichloropropene was not listed in the Contract Laboratory Program (CLP) Statistical Database.

5. POTENTIAL FOR HUMAN EXPOSURE

5.2.3 Soil

The most common release of 1,3-dichloropropene to soil occurs in agricultural fields where it is applied as a soil fumigant (Cohen 1986; Krijgsheld and Van der Gen 1986; Maddy et al. 1982a). Accidental spills may also release 1,3-dichloropropene to soil (Markovitz and Crosby 1984; Sterrett et al. 1986). For example, on April 8, 1984, a rail accident that occurred about 45 miles southeast of Tucson, Arizona resulted in a spill of 15,000 gallons of 1,3-dichloropropene (Sterrett et al. 1986).

1,3-Dichloropropene may be released to soil via the leachates of landfills and hazardous waste sites (Hauser and Bromberg 1982; Sabel and Clark 1984). The EPA has identified 1,177 NPL hazardous waste sites. cis-1,3-Dichloropropene has been identified at three of the sites evaluated for the presence of this chemical (View 1989) (soil, water, and air samples are not differentiated). However, we do not know how many of the 1,177 NPL sites have been evaluated for this chemical. As more sites are evaluated by the EPA, the number may change.

5.3 ENVIRONMENTAL FATE

5.3.1 Transport and Partitioning

The transport and partitioning of an organic compound in the environment is a function of the physical and chemical properties of that compound and the site-specific characteristics of the environment (e.g., percent soil organic matter). Based upon similarities in their physical and chemical properties, cis- and trans-1,3-dichloropropene should behave similarly in regards to transport and partitioning within the environment.

In the atmosphere, the respective vapor pressures of cis- and trans-1,3-dichloropropene of 43 and 34 mmHg at 25°C (Dilling 1977) suggest that these compounds will exist predominantly in the vapor phase (Eisenreich et al. 1981). The water solubilities of cis- and trans-1,3-dichloropropene of 2,700 and 2,800 ppm, respectively (Dilling 1977), indicate that wet deposition may remove them from the atmosphere. This is confirmed by the detection of 1,3-dichloropropene in rainwater (Section 5.4.2).

In surface waters, volatilization of 1,3-dichloropropene should be an important fate process that will compete with the transformation processes of biodegradation or slow hydrolysis (Section 5.3.2.2). Experimentally measured Henry's law constants (the reciprocal of the solubility when the partial pressure of the solute is 1 atmosphere) for cis- and trans-1,3-dichloropropene of 1.2×10^{-3} and 8.0×10^{-4} atm-m³/mol at 20°C, respectively (Leistra 1970), indicate that volatilization from environmental waters is probably significant (Thomas 1982). Using the method of Thomas (1982), the estimated volatilization half-lives of cis- and trans-1,3-dichloropropene from a model river 1 meter deep, flowing at a velocity of 1m/sec with a wind velocity of

5. POTENTIAL FOR HUMAN EXPOSURE

73m/sec are 3.8 and 4.2.hours, respectively. Using EPA's EXAMS II computer simulation model (EPA 1986a), which considers the effects of adsorption, the corresponding estimated volatilization half-lives from a model pond with a depth of 2 meters are 46 and 50 hours. These half-life estimates suggest that volatilization from most natural waters is an important fate process for 1,3-dichloropropene.

Experimental data pertaining to the adsorption of 1,3-dichloropropene to aquatic sediments were not available in the literature. However, the relatively high water solubilities of 2,700 and 2,800 ppm for cis- and trans-1,3-dichloropropene (Dilling 1977) suggest that 1,3-dichloropropene is more likely to remain in solution than become adsorbed to suspended materials and sediment.

In soil, 1,3-dichloropropene can exist as a gas or dissolved in water. The adsorption characteristics for each form are different. Experimental K_{oc} values for cis- and trans-1,3-dichloropropene in aqueous solutions are reportedly 23 and 26, respectively (Kenaga 1980). These K_{oc} values indicate a high mobility in soil (Swann et al. 1983) and a potential for leaching. Although movement in saturated soils is possible, concurrent hydrolysis and biodegradation should attenuate the amounts of 1,3-dichloropropene that may actually leach to groundwater. Furthermore, extensive groundwater monitoring programs, conducted in California, have not demonstrated that 1,3-dichloropropene is contaminating well waters in areas of continued field applications of the pesticide (Cohen 1986; Maddy et al. 1982b).

1,3-Dichloropropene more strongly adsorbs to soil when it is in the vapor phase than when it is dissolved in water (Munnecke and Vangundy 1979). Adsorption for the vapor phase depends partly upon the soil's temperature and organic content (Leistra 1970). Soil adsorption isotherms indicate increasing adsorption with increasing organic content, and adsorption is approximately 3 times greater at 2°C than it is at 20°C. Adsorption isotherms measured for humus sand, peaty sand, and peat indicate vapor-phase K_{oc} values for 1,3-dichloropropene ranging from about 450 to 750. These K_{oc} values suggest medium to low soil mobility for 1,3-dichloropropene in the vapor phase in soil (Swann et al. 1983).

Volatilization of 1,3-dichloropropene from soil is an important physical removal mechanism. After application as a soil fumigant, the amount of 1,3-dichloropropene that volatilizes can vary greatly with application methods, temperature, moisture content, soil porosity, and soil organic content (Albrecht and Chenchin 1985). During laboratory experiments conducted in jars designed to trap escaping vapors, the majority of 1,3-dichloropropene applied to a soil evaporated (Roberts and Stoydin 1976). In warm, moist, sandy loam soils, 5%-10% of the 1,3-dichloropropene applied at a depth of 0.3 meters was lost to evaporation (Munnecke and Vangundy 1979; Thomas and McKenry 1974).

5. POTENTIAL FOR HUMAN EXPOSURE

The persistence of 1,3-dichloropropene in soil has been measured by a number of investigators. Van der Pas and Leistra (1987) reported half-lives of 3-4 days in fields used for planting flower bulbs. Only very small amounts of 1,3-dichloropropene remained after periods up to 49 days. Leistra (1970) reported a much slower degradation rate of 0.035/day for a loam soil, which corresponds to a half-life of 19.8 days. A degradation rate of 0.01/day, which corresponds to a half-life of 69 days, was reported for sandy and peat soils (Leistra 1970). Albrecht (1987) has reported half-lives of 3-25 days at 20°C for 1,3-dichloropropene. Radiolabeled cis- and trans-1,3-dichloropropene was applied to soils and stored in sealed jars for 12 weeks. In a sandy loam soil, 19% of the cis isomer and 18% of the trans isomer remained, while 10% of the cis isomer and 22% of the trans isomer persisted in a medium loam soil (Roberts and Stoydin 1976).

As discussed in Section 5.3.2.3, 1,3-dichloropropene can be removed from soils via hydrolysis, microbial degradation, and volatilization. Since the rate of these processes can vary significantly with soil conditions, the wide range of reported persistence half-lives is not surprising and demonstrates that the persistence of 1,3-dichloropropene in soil depends upon specific local conditions.

5.3.2 Transformation and Degradation

5.3.2.1 Air

The important environmental fate process for the degradation of 1,3-dichloropropene in ambient air is the vapor-phase reaction with photochemically produced hydroxyl radicals. The rate constants for the reactions of cis- and trans-1,3-dichloropropene with hydroxyl radicals have been experimentally determined to be 7.7×10^{-12} and 1.3×10^{-11} cm³/molecule-sec at 22°C, respectively (Tuazon et al. 1984). 1,3-Dichloropropene will also be removed from air via reaction with ozone; however, this reaction is expected to be secondary to photooxidation with hydroxyl radicals. The rate constants for the reactions of cis- and trans-1,3-dichloropropene with ozone molecules have been experimentally determined to be 1.5×10^{-19} and 6.7×10^{-19} cm³/molecule-sec at 22°C, respectively (Tuazon et al. 1984). Assuming that the average yearly troposphere hydroxyl radical and ozone molecule concentrations are 5.0×10^5 and 7.0×10^{11} molecules/cm³, respectively (Atkinson 1979), the corresponding half-lives for cis-1,3-dichloropropene in air are about 2.1 days (50 hours) and 76 days. The corresponding half-lives for trans-1,3-dichloropropene in air would be about 1.2 days (30 hours) and 17 days. Tuazon et al. (1984) calculated the respective half-lives of 52 and 12 days for cis- and trans-1,3-dichloropropene reactions with ozone based on an average background tropospheric concentration for ozone of 1.0×10^{12} molecules/cm³. For the cis and trans isomers, the authors also calculated respective half-lives of 12 and 7 hours for the reactions with photochemically generated hydroxyl radicals present at an average concentration of 2.0×10^5 molecules/cm³ (Tuazon et al. 1984).

5. POTENTIAL FOR HUMAN EXPOSURE

The estimates of average hydroxyl radical and ozone concentrations in air used by Tuazon et al. (1984) are more indicative of urban atmospheres. In general, the hydroxyl radical and ozone concentrations in polluted air may increase by an order of magnitude over those estimates used by Atkinson (1979). Therefore, the half-life of 1,3-dichloropropene in ambient air may range between 7 and 50 hours, depending on the concentrations of cis- and trans-isomers and hydroxyl radicals in the troposphere.

Formyl chloride and chloroacetaldehyde have been identified as reaction products of 1,3-dichloropropene with both hydroxyl radicals and ozone. Reaction with ozone also yields chloroacetic acid, formic acid, hydrogen chloride, carbon dioxide, and carbon monoxide (Tuazon et al. 1984).

1,3-Dichloropropene is also susceptible to photolysis in air. However, direct photodegradation of 1,3-dichloropropene should not be an important fate process, compared to its reaction with hydroxyl radicals (Mabey et al. 1981). Nevertheless, some evidence that the photodecomposition of 1,3-dichloropropene may be enhanced by the presence of atmospheric particulates exists (Tuazon et al. 1984).

5.3.2.2 Water

River die-away test data pertaining to the biodegradation of 1,3-dichloropropene in natural waters were not available in the literature. Several aerobic biological screening studies, which used settled domestic waste water for inocula, demonstrated that 1,3-dichloropropene is biodegradable (Tabak et al. 1981a, 1981b). Within 7 days, the original cultures, added to synthetic media that contained 5 mg yeast extract/L, were able to degrade about 50% of the 1,3-dichloropropene at an initial concentration of 10 ppm (Tabak et al. 1981a, 1981b). Acclimation to a series of subcultures was also demonstrated. The third subculture, with identical concentrations and under identical conditions, showed an approximate 85% removal of 1,3-dichloropropene within the same period of time (Tabak et al. 1981a, 1981b). Nevertheless, the rate of biodegradation for 1,3-dichloropropene in natural waters cannot be inferred from screening study data.

In addition to losses via biodegradation, 1,3-dichloropropene may undergo slow hydrolysis in natural waters. Castro and Belser (1966) found that 1,3-dichloropropene hydrolyzed about 1.4 times slower in buffered solution than in soil-water suspensions with a soil:water ratio of 0.5 (Section 5.3.2.3).

5.3.2.3 Soil

1,3-Dichloropropene reportedly biodegrades in soil (Castro and Belser 1966, 1968; Roberts and Stoydin 1976; Tu 1988, Van der Pas and Liestra 1987). Belser and Castro (1971) reported that the microbial degradative pathway for

5. POTENTIAL FOR HUMAN EXPOSURE

both the cis and trans isomers followed a similar sequence. The initial step of the reaction involves allylic dechlorination of 1,3-dichloropropene and hydroxyl substitution to form the corresponding chloroallyl alcohol (Castro and Belser 1966; Roberts and Stoydin 1976). Again, both cis- and trans-chloroallyl alcohols undergo oxidation, resulting in the formation of the corresponding chloroacrylic acids (Castro and Belser 1968; Roberts and Stoydin 1976). Next, vinylic chlorines are removed and subsequent, propanoic acid 3-aldehyde is oxidized to carbon dioxide (Belser and Castro 1971),.

1,3-Dichloropropene may also hydrolyze in moist soils. In laboratory studies, hydrolysis rates have been measured in soil slurries and buffer solutions. For soil-water slurries with a concentration of 10^{-2} M, 1,3-dichloropropene hydrolyzed at a rate of 3.4% per day (Castro and Belser 1966). In general, soils possess a relative humidity greater than 98%. Under dry conditions, the relative humidity of soil may fall below 90% (Morrill 1985). Therefore, 1,3-dichloropropene is likely to hydrolyze in most soils. Once again, corresponding chloroallyl alcohols were reported as the products of hydrolysis for cis- and trans-1,3-dichloropropene (Castro and Belser 1966).

5.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT

5.4.1 Air

1,3-Dichloropropene is not a widely occurring atmospheric pollutant. According to the National Ambient Volatile Organic Compounds (VOCs) Database, a compilation of published and unpublished air monitoring data from 1970 to 1987, the median urban atmospheric concentration of cis-1,3-dichloropropene is 23.9 ppbV (parts per billion by volume) for 148 samples collected from representative locations (Shah and Heyerdahl 1989). Information regarding the occurrence of cis-1,3-dichloropropene in suburban, rural, remote, sourcedominated (air surrounding a facility or known release of the chemical in question), workplace, and indoor and personal atmospheres was not included by the VOC database. Also, no data were reported for trans-1,3-dichloropropene (Shah and Heyerdahl 1989).

No other monitoring data on the presence of 1,3-dichloropropene in ambient air were available in the literature.

5.4.2 Water

Monitoring information pertaining to the occurrence of 1,3-dichloropropene in surface waters was unavailable in the literature. STORET (1989) did not contain any unremarked records (those data points that are not noted to be less than a given value, usually the detection limit) for cis- and trans-1,3-dichloropropene in ambient surface water.

STORET (1989) also did not contain unremarked records for cis- and trans-1,3-dichloropropene in groundwater. 1,3-Dichloropropene was detected in

5. POTENTIAL FOR HUMAN EXPOSURE

groundwater contaminated by leachates from municipal landfills in New York, Minnesota, and Wisconsin at concentrations up to 18 µg/L (Sabel and Clark 1984). In California, 1,3-dichloropropene was detected in groundwater at unspecified concentrations as a result of pesticide applications (Cohen 1986). An extensive groundwater monitoring program for agricultural chemicals in California detected cis-1,3-dichloropropene in only two groundwater samples, and trans-1,3-dichloropropene in only one groundwater sample (Cohen 1986). By comparison, dibromochloropropane, another soil fumigant, was detected in 2,522 groundwater samples. In 54 municipal wells of varying depths of 65-1,200 feet in areas of California where Telone® or DD® had been applied for over 15 years, 1,3-dichloropropene was not detected in any sample at or above the quantification limit of 0.1 ppb (Maddy et al. 1982b).

1,3-Dichloropropene was qualitatively identified in New Orleans, Louisiana, drinking water collected in August 1974 (Dowty et al. 1975a, 1975b). An analysis of 15 drinking water samples from Denver collected between October 1, 1985, and March 31, 1986, did not detect cis- or trans-1,3-dichloropropene at or above detection limits of 0.13 ppb (Rogers et al. 1987). At quantities above the detection limit of 0.1 ppb, 1,3-dichloropropene was not detected in 42 raw and 42 finished drinking water samples collected between July 1982 and May 1983 from nine municipalities along the Great Lakes (Otson 1987).

Concentrations of 10 and 2 ng of cis- and trans-1,3-dichloropropene/L, respectively, were detected in rainwater collected in Portland, Oregon, in 1982 (Mazurek and Simonetti 1986).

5.4.3 Soil

Monitoring data pertaining to 1,3-dichloropropene found in soil were not located in the available literature.

5.4.4 Other Environmental Media

1,3-Dichloropropene is not a naturally occurring product (IARC 1986). Information pertaining to the its presence in other media could not be located in the available literature.

Daft (1989) examined 231 different ready-to-eat foods (collected during the U.S. Food and Drug Administration's Market Basket Survey) for 22 fumigants and industrial residues. Although analyzed for (at a detection limit of about 1 ppb), 1,3-dichloropropene was not detected in any food sample.

5.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE

Possible routes of human exposure to 1,3-dichloropropene include the inhalation of vapors, ingestion of contaminated foods and drinking water, and dermal contact.

5. POTENTIAL FOR HUMAN EXPOSURE

Monitoring data regarding the presence of 1,3-dichloropropene in foods were not located (see Section 5.4.4). It has been suggested that chlorination of water can lead to the formation of 1,3-dichloropropene, and that the detection of 1,3-dichloropropene in various water samples confirm this (Krijgsheld and Van der Gen 1986). However, information pertaining to the occurrence of 1,3-dichloropropene in drinking water is also very limited.

Very few atmospheric monitoring data for 1,3-dichloropropene exist in the literature. Because substantial quantitative information for air, food, and drinking water is not available, the respective average daily intakes were not calculated.

Occupational exposures to 1,3-dichloropropene, mainly during handling and application as a soil fumigant, have been documented (Albrecht 1987; Albrecht et al. 1986; Markovitz and Crosby 1984; Nater and Gooskens 1976; Osterloh et al. 1984, 1989a, 1989b; Schenker and McCurdy 1986; van Joost and Jong 1988; Wang 1984). According to the NOES conducted by NIOSH between 1980 and 1983, it has been estimated that 1,779 workers were potentially exposed to 1,3-dichloropropene in the workplace in 1980 (NIOSH 1989). The NOES data base does not contain information on the frequency, concentration, or duration of workers' exposure to any of the chemicals listed therein. The survey provides only estimates on the number of workers potentially exposed to chemicals in the workplace. The most probable routes of occupational exposure are inhalation and dermal contact at places where 1,3-dichloropropene- and/or 1,3-dichloropropene-containing compounds are produced or used as a soil fumigant. Albrecht (1987) studied the inhalation exposure of 1,3-dichloropropene to workers involved in applying Telone II to pineapple fields in Hawaii. Exposures were predominantly below 1 ppm.

The Monsanto Agricultural Products Company conducted research to ensure that workers in the workplace were not being exposed to unacceptable levels of 1,3-dichloropropene in the air during its manufacture. Under laboratory conditions simulating the workplace environment, atmospheric levels of 1,3-dichloropropene ranged from 0.4 to 4.0 ppm (Leiber and Berk 1984).

Populations that live near hazardous waste sites may be exposed to 1,3-dichloropropene; however, only three hazardous waste sites of an unknown number of evaluated sites have been found to contain it.

Pertinent monitoring data regarding the dermal exposure of 1,3-dichloropropene were not located in the available literature. Dermal exposure is possible for workers involved in fumigant applications of 1,3-dichloropropene.

5.6 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

High levels of exposure to 1,3-dichloropropene are most likely to occur in occupational settings where 1,3-dichloropropene is either produced or used

5. POTENTIAL FOR HUMAN EXPOSURE

as a soil fumigant. Intake by inhalation or dermal contact is the most probable route of high exposure to 1,3-dichloropropene. 1,3-Dichloropropene is a volatile compound and, after soil application as a fumigant, a fraction of the compound will volatilize and escape into the atmosphere (Krijgsheld and Van der Gen 1986).

5.7 ADEQUACY OF THE DATABASE

Section 104(i)(5) of CERCLA as amended directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of 1,3-dichloropropene is available. Where adequate information is not available, ATSDR, in conjunction with the NTP, is required to assure the initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of 1,3-dichloropropene.

The following categories of possible data needs have been identified by a joint team of scientists from ATSDR, NTP, and EPA. They are defined as substance-specific informational needs that, if met, would reduce or eliminate the uncertainties of human health assessment. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

5.7.1 Data Needs

Physical and Chemical Properties. The physical and chemical properties of both cis- and trans-1,3-dichloropropene have been described and are readily available in the literature (CLOGP-PCGEMS 1989; Dilling 1977; EPA 1981; Kenaga 1980; Leistra 1970; OHM/TADS 1989; Sax and Lewis 1987; Verschueren 1983; Weast et al. 1988; Windholz et al. 1983). Some of these physical properties were required for assessing the fate and transport of 1,3-dichloropropene in the environment because experimental data were not available. The literature values were sufficient for performing the necessary estimates (Lyman et al. 1982).

Production, Import/Export, Use, and Disposal. Current production and import/export volumes are unavailable in the literature. Much of the information regarding 1,3-dichloropropene has been included in combination with other chemicals. For example, USITC (1989) data for 1,3-dichloropropene are grouped with other soil fumigants. Historical production volumes are well documented (Yang 1986), but information regarding future domestic production, and past, present, and future imports and exports are lacking in the literature. With up-to-date and accurate production/import/export data, the extent of release into the environment and the subsequent potential for human exposure could be more realistically determined.

5. POTENTIAL FOR HUMAN EXPOSURE

According to the Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. Section 11023, industries are required to submit chemical release and off-site transfer information to the EPA. The Toxic Release Inventory (TRI), which contains this information for 1987, became available in May of 1989. This database will be updated yearly and should provide a list of industrial production facilities and emissions.

Literature pertaining to the use of 1,3-dichloropropene as a agricultural soil fumigant is readily available (Krijgsheld and Van der Gen 1986). Yet, monitoring data that showed the existence of 1,3-dichloropropene in food were not located. 1,3-Dichloropropene has been monitored in drinking water supplies with a low frequency of occurrence (Dowty et al. 1975a, 1975b; Otson 1987; Rodger et al. 1987). Disposal methods have been described and appear to be satisfactory. Information concerning the numbers of persons potentially exposed to 1,3-dichloropropene near waste sites and manufacturing, production, and use facilities, however, is not available. In these areas and those of widespread use, the potential for human exposure is high.

Environmental Fate. Information concerning the partitioning of 1,3-dichloropropene in the environment is available (Cohen 1986; Dilling 1977; EPA 1986a; Kenaga 1980; Leistra 1970; Maddy et al. 1982; Munnecke and Vangundy 1979; Roberts and Stoydin 1976; Thomas and McKenry 1974; Van der Pas and Leistra 1987); 1,3-dichloropropene occurs in all environmental media. Information on the transport of 1,3-dichloropropene in environmental media is also available (Albrecht 1981; Cohen 1986; Dilling 1977; EPA 1986a; Leistra 1970; Maddy et al. 1982; Munnecke and Vangundy 1979; Roberts and Stoydin 1976; Swann et al. 1983; Thomas 1982; Van der Pas and Leistra 1987); however, precisely and accurately predicting the behavior of 1,3-dichloropropene in the environment is difficult because of the influence of site-specific environmental characteristics and the effects of competing fate processes, such as volatilization and adsorption. Likewise, we do not know if 1,3-dichloropropene is transported long distances from its point of release in air, nor do we know the rate of photolysis in the presence of atmospheric particulate matter. A better understanding in these areas will enable scientists to more accurately assess the extent of human exposure to 1,3-dichloropropene, especially among populations living near points of release to the environment.

Bioavailability from Environmental Media. Case reports of people who have experienced 1,3-dichloropropene poisoning following oral, dermal, and inhalation exposure indicate that 1,3-dichloropropene can be absorbed by these routes (Albrecht 1987; Markovitz and Crosby 1984; Hater and Gooskens 1976; Osterloh et al. 1984, 1989). However, no information is available regarding oral or dermal absorption of 1,3-dichloropropene in water, soil, or plant material. Studies of absorption of 1,3-dichloropropene from air, water, soil, and plant material would allow determination of the rate and extent of

5. POTENTIAL FOR HUMAN EXPOSURE

absorption from each of these media, and allow comparison of the potential hazard posed by 1,3-dichloropropene contained in each.

Food Chain Bioaccumulation. Few data are available describing the food chain bioaccumulation of 1,3-dichloropropene. Experimental data are unavailable; therefore, we do not know if the bioconcentration potential is consistent with estimated values obtained from regression equations (Lyman et al. 1982). Information concerning the potential for food chain biomagnification has not been described. Knowledge in this area would enable scientists to assess the dangers of human exposure to 1,3-dichloropropene via food such as fish and seafoods.

Exposure Levels in Environmental Media. Information on exposure levels in environmental media is largely unavailable. Data describing the exposure levels in air, surface water, and groundwater (sources of groundwater contamination include hazardous waste sites) are lacking. For 1,3-dichloropropene, estimates of human intake via air, water, and food are not available. Additional information, particularly for waste sites, would be helpful in describing the potential dangers of human exposure to 1,3-dichloropropene in the environment.

Exposure Levels in Humans. 1,3-Dichloropropenes are not naturally occurring substances (IARC 1986). Available information shows that N-acetyl cysteine is present in the urine of people who were occupationally exposed to 1,3-dichloropropene (Osterloh et al. 1984, 1989a, 1989b). Additional information regarding the utility of this biomarker as an indicator of general population exposure to the compound may be useful in monitoring the frequency of human exposure to 1,3-dichloropropene.

Exposure Registries. No exposure registries for 1,3-dichloropropene were located. This compound is not currently one of the compounds for which a subregistry has been established in the National Exposure Registry. The compound will be considered in the future when chemical selection is made for subregistries to be established. The information that is amassed in the National Exposure Registry facilitates the epidemiological research needed to assess adverse health outcomes that may be related to the exposure to the compound.

Populations near hazardous waste sites and manufacturing, production, and use facilities may be exposed both from elevated air concentrations and from drinking contaminated groundwater (Bean et al. 1985; Cohen 1986; Dowty et al. 1975; Hauser and Bromberg 1982; Krijgsheld and Van der Gen 1986; Lao et al. 1982; Maddy et al. 1982; Markovitz and Crosby 1984; Otson 1987; Rawlings and Samfield 1979; Rodgers et al. 1987; Sabel and Clark 1983; Sterrett et al. 1986). No registries are available that document the exposure of these populations to 1,3-dichloropropene. An exposure registry would provide a reference for assessing exposure levels and frequencies of exposure to

5. POTENTIAL FOR HUMAN EXPOSURE

1,3-dichloropropene. It will also facilitate the conduct of epidemiological or health studies that evaluate any adverse health effects resulting from 1,3-dichloropropene exposure. In addition, a registry based upon exposure sources will allow the assessment of variations in exposure levels between sources and the effects of geographical, seasonal, and regulatory actions on the level of exposure within a certain source.

5.7.2 On-going Studies

For 1,3-dichloropropene, as well as other halogenated hydrocarbons, the reactions and movement in soil are a concern of ongoing investigations (Federal Research in Progress 1988). The U.S. Dept. of Agriculture-Cooperative State Research Service (USDA-CSRS) is sponsoring research at New Haven, Connecticut, regarding the sorption of 1,3-dichloropropene by sterile and nonsterile soils under anaerobic and aerobic conditions. The rate of desorption is being examined with the leaching of water and other solvents through the soils. Similar studies, dealing with soil retention and leachability among field soils, are in progress at the University of Florida, Gainesville, Florida.

The USDA-CSRS, at the University of Clemson in South Carolina, is studying ways to more effectively use chemical nematicides in the field. The goal is to develop more efficient means in which to apply soil fumigants (Federal Research in Progress 1988).

Worker exposure to 1,3-dichloropropene and other pesticides is currently being assessed by the USDA-CSRS, at the University of California in Davis, California (Federal Research in Progress 1988). Worker exposure levels of 1,3-dichloropropene are being monitored in the soil and air during the handling, storage, and application of the chemical. Local distributors and warehouse employees are being monitored in addition to the field applicators.

A remedial investigation and feasibility study conducted at the three NPL sites known to be contaminated with 1,3-dichloropropene will add to the available database on exposure levels in environmental media, exposure levels in humans, and exposure registries; this will also increase the current knowledge regarding the transport and transformation of 1,3-dichloropropene in the environment.

As part of the Third National Health and Nutrition Evaluation Survey (NHANES III), the Environmental Health Laboratory Sciences Division of the Center for Environmental Health and Injury Control, Centers for Disease Control, will be analyzing human blood samples for 1,3-dichloropropene and other volatile organic compounds. These data will give an indication of the frequency of occurrence and background levels of these compounds in the general population.

